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An analysis of road accidents caused by the current road infrastructure in Romania

Gheorghe Neamțu[1], Marinela Ință[2]

[1] "Lucian Blaga" University of Sibiu, 10 Victoriei Street, Sibiu, Romania, ORCID 0000-0001-9043-9962
[2] "Lucian Blaga" University of Sibiu, 10 Victoriei Street, Sibiu, Romania, ORCID 0000-0003-0117-7652

E-mail: *geluneamtu@yahoo.com, marinela.inta@ulbsibiu.ro*

Abstract. The scientific paper presents in a concrete and elegant way an analysis of how the poor quality and insufficiency of the current road infrastructure in Romania negatively influences road safety. The existing road infrastructure in our country is built and developed on the basis of roads built in the 1950s and 1960s, largely modernised, but still insufficient in terms of high speed roads. Specialists in the field consider that average traffic speeds on the existing road infrastructure at that time are largely influenced by a number of factors that are exclusively related to it. A high density of localities and the roads that cross them, the topography, the climate, traffic jams, the defective way of action of the authorities, sometimes the lack of horizontal and vertical signalization, the obstacles encountered at every turn, the non-conforming, undersized design or construction of traffic lanes and other elements of infrastructure, current legislation with many interpretations, heavy, heterogeneous and congested traffic, all of which make traffic participants unsafe and stressful and generate serious road events or accidents, resulting in human casualties and significant material damage. At national level, these are just a few of the most important issues negatively affecting infrastructure. In order to remove these negative, nonconforming aspects, which do not add value to the modern society it serves, it is imperative that major investments are undertaken in a relatively short time to develop a modern, sustainable and durable road infrastructure. In this way, those interested can find out the current state of research in the field, as well as data and figures on the number of road accident fatalities caused by the poor state of road infrastructure in Romania. The road safety management carried out on the current road infrastructure and the degree of sustainability provided by the authorities is then presented. At the end of the paper, conclusions in the field are presented.

Keywords: *safety, infrastructure, road accident, fatalities, management, sustainability.*

Introduction

Road infrastructure [1, p. 474], [2, pp. 30-32], [3] is a sector which covers the optimal use of land space and the programming of all facilities, reconstruction, design of parts of roads and/or intersections, horizontal and vertical signalling, traffic quality assurance procedures (audit, impact analysis and road safety inspections). In Romania, road infrastructure is the central, basic element of the road transport system. It is made up of the essential elements that ensure the smooth operation of transport services on high-speed roads (motorways and expressways), national roads, county roads,

municipal roads, service roads, boulevards and urban streets. At the same time, it provides all the existing functions and facilities necessary for the safe and normal flow of road traffic as a constituent part of it. One of the inconsistencies of Romania's road network is that a large number of roads pass through villages, communes or towns. In this case, there is an acute lack of ring roads or bypasses. According to a 2019 Economic Forum Report, Romania ranks 119th out of 141 countries surveyed in terms of road network quality [4, p. 479]. The road infrastructure at national level must reach a level of development that allows the mobility needs of all goods and passengers to be met in optimal conditions, so as to ensure the capacity, quality and safety required by European standards. The investments that have taken place so far in infrastructure do not ensure the safety of traffic participants because half of the road surfaces of the reconstructed roads are deficient and have the norm of duration met. Given the inadequate road infrastructure situation, we believe that in the last 30-35 years, our country has designed and implemented its public transport policies contrary to those developed by the EU, contrary to its own medium and long-term interests. The implementation of measures with major effectiveness in reducing the number of road accidents with serious consequences and, in particular, the number of people killed as a result of them, requires a tool for national evaluation and analysis of the diverse and complex data characterising road traffic on the roads in Romania [5]. This is why it is necessary that future road projects of any kind to be built on the territory of Romania improve road links between major urban centres, increase road safety, improve traffic flow and have major implications on the formation of areas of territorial influence. The main objective of the paper is to highlight the current shortcomings, which are analysed through the prism of road accidents generated by the poor road infrastructure in Romania in the period January 1, 2021 – December 31, 2023.

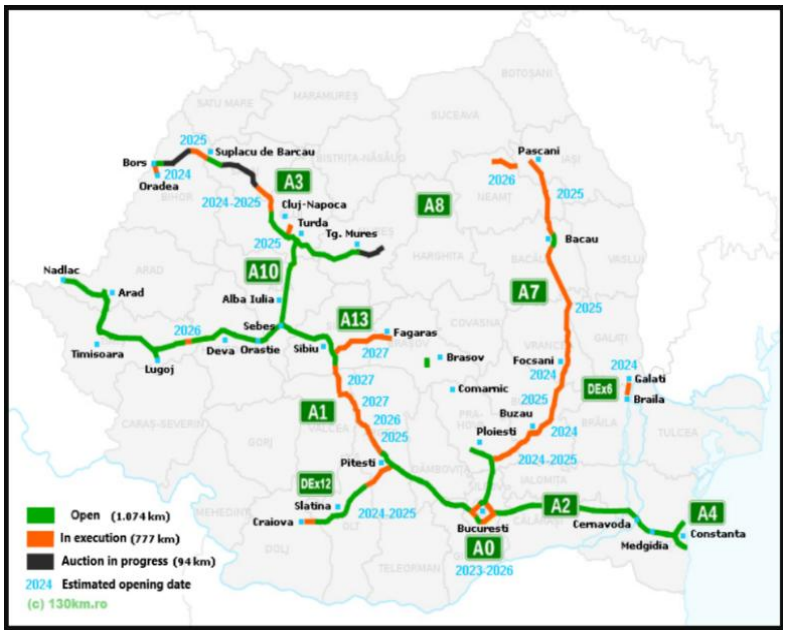

Figure 1. Situation of existing motorways in Romania on December 31, 2023 [17].

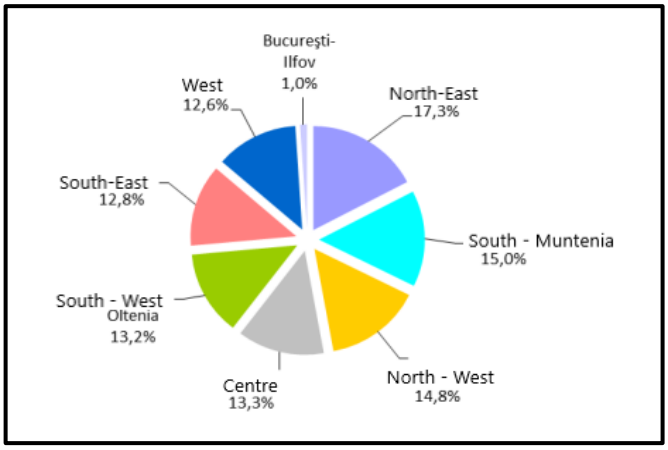

Figure 2. Structure of the public road network by development region as at December 31, 2022 [6, p. 2].

1. Current state of road infrastructure

Analysing the network of motorways and expressways existing at that time in Romania (fig. 1), the following can be stated: before the Revolution of December 1989, only 113 km of

motorways were built. Between December 1989 and 2007, when Romania joined the European Union (transition period), only 148 km of motorways were built and approved, bringing the total to 261 km. Between 2008 and 2017, European funds for infrastructure development were accessed and another 487 km were built, bringing the total to 748 km of motorway. At the end of 2018, the national motorway network had reached 823 km. Of these, only 101 km were completed in 2018, but only 60 km were put into service. After a long period of waiting, the 13 km of motorway in Lot 1, Sibiu - Boița, have also been handed over. On December 31, 2022 in Romania there was a total of 982 km of motorway, and on December 31, 2023 in our country are built a total of 1,074 km of high-speed roads (motorways and express roads, according to data presented in Figure 1), being ranked last in Europe. The map shows the national motorway and expressway projects according to the latest available information. It includes all motorways and express roads in operation (routes marked in green), but also motorways and express roads in the construction phase (routes marked in orange), or at the project stage (routes marked in black). The map is constantly updated and involves regular (quarterly) changes when new express roads or motorways are opened. Figure 2 shows the structure of the public road network, by development region, on December 31, 2022, and Table 1 shows the statistical data on the total length (km), by category, of the existing roads in Romania on December 31, 2021 and December 31, 2022 respectively. The SARS-CoV-2 pandemic negatively influenced this index in 2021 and 2022.

Table 1. Total length (km), by category, of existing roads in Romania on December 31, 2021 and December 31, 2022 respectively [6].

Road categories	December 31, 2021			December 31, 2022		
	National roads	County roads	Communal roads	National roads	County roads	Communal roads
Modernized roads	16.740	16.540	7.291	16.813	17.268	7.572
Roads with light road surfaces	635	12.800	7.677	639	12.618	7.699
Paved roads	137	4.238	11.809	112	3.818	11.738
Earth roads	18	1.518	6.796	18	1.428	6.568

If we analyse the aspects presented in Table 1, according to the data provided by the National Institute of Statistics (NIS) on December 31, 2022, the length of public roads in our country totalled 86,336 km, of which a percentage of 20.4% representing 17,582 km belonging to the category of national roads, a percentage of 40.7% representing 35,132 km belonging to the category of county roads and a percentage of 3.9% representing 33,622 km belonging to the category of municipal roads [6]. Analysed from the point of view of the type of surfacing, the road infrastructure in Romania is as follows: 48.2% representing 41,653 km of upgraded roads (approximately 94.1% upgraded roads with heavy and medium asphalt surfacings), 24.3% representing 20,956 km of roads with light road surfacings and 27.5% representing 23,727 km of paved and earth roads [6]. With regard to the technical condition of public roads, 29.9% of the length of upgraded roads and 41.1% of the length of light surfaced roads are outdated in terms of service life [6]. At the same time, of the length of national roads, 35.2% representing 6,197 km are European roads, 5.4% representing 949 km are motorways, and in terms of the number of traffic lanes, 11.7% representing 2,064 km are 4-lane roads, 1.8% representing 308 km are 3-lane roads and 0.2% representing 35 km are 6-lane roads [6]. 49.2% of the length of county roads were upgraded roads and 35.0% of the municipal roads were paved roads [6].

As regards road density per 100 km2 of national territory, Table 2 shows its evolution between 1990 and 2021 compared to 1990.

Table 2. Road density per 100 km^2 of national territory [7, p. 32], [8].

Year	1990 (%)	2010 (%)	2011 (%)	2019 (%)	2020 (%)	2021 (%)
Road density per 100 km^2 of territory	30,5	34,6	35,1	36,2	36,4	36,2

The data presented in Table 2 show that road density per 100 km^2 of territory has been steadily increasing, but not enough. Due to this, the specific indicator managed to increase in 2020 compared to 1990 by only 5.9%, but slightly decreased in 2021 by 0.54%, thus reaching the level of 2019 again. Bucharest and Ilfov had the highest road network densities per 100 km2 of territory at the end of 2021, with 50 km, followed by South-West Oltenia with 38.9 km and North-East with 40.6 km. The infrastructure is rather deficient between regions, especially between industrial or commercial centres, and road traffic passing through rural and urban areas creates major traffic jams. The acute lack of high-speed infrastructure at national level has a negative impact on the mobility index of goods and population. [9]. The mobility index, based on the formula: millions of road vehicles x kilometres travelled, has been increasing steadily from year to year.

Table 3 shows the dynamics of the road mobility index and its evolution between 2010 and 2020.

Table 3. Dynamics of the road mobility index and its evolution between 2010 and 2020 [7, p. 33].

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mobility index*	73.251	74.513	80.853	85.687	90544	96.284	104.612	127.133	157.252	175.427	146.921
Annual evolution (%)	0	+1,7	+8,5	+6,0	+5,7	+6,3	+8,7	+21,5	+23,7	+11,6	-16,3

* Expressed as the product of 1 million vehicles and kilometres travelled.

In 2019 the mobility index increased by 140%, much higher than in 2010. The most impressive year-on- year increases were recorded in 2017 (+21.5%) and 2018 (+23.7%), but due to the restrictions imposed by the Romanian authorities during the SARS-CoV-2 pandemic in 2020, compared to 2019, the national road mobility index decreased from 175,427 million vehicles multiplied by vehicle kilometres travelled to 146,921 million vehicle kilometres travelled (-16.3%) [7, pp. 33-34].

2. Analysis of road accidents caused by the poor state of the existing road infrastructure in Romania. Results and discussions

In 2021, 26,806 road events occurred on Romania's road infrastructure, 4,915 (18.3%) were serious accidents, resulting in 1,779 fatalities, serious injuries to 3,790 road users and slight injuries to 2,235 others. On average, every day in 2021 there were 13 serious road traffic events in which five people died and ten were seriously injured [7, p. 34]. An analysis of the main indicators that define the road events that occurred in 2021 shows an increase in the number of slight accidents. In 2021 in Romania there were 5,356 more low impact events, representing an increase of 32.4%

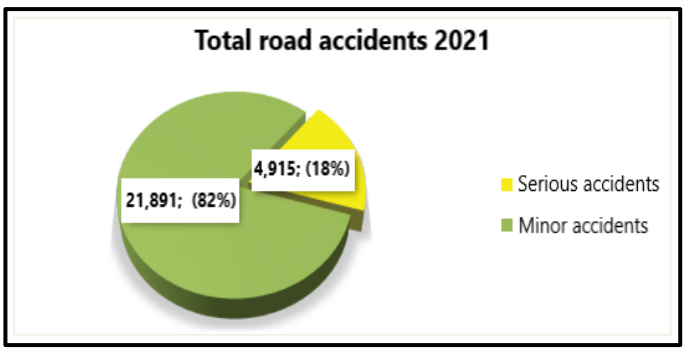

Figure 3. The total numbers of road accidents at national level in 2021 [7, p. 34].

compared to the previous year. In this case, an increase of 3.7% (+80) in the number of road accident victims who were slightly injured is observed. In terms of serious road traffic events, in 2021 at national level there were 1,356 fewer road traffic events compared to the previous year (-21.6%), during which time the number of injuries (deaths or serious injuries) in such events was lower by 1,559, representing a decrease of 21.9% [7, p. 8]. Figure 3 shows the total number of road accidents by category, occurring at national level in 2021. Figure 4 shows the situation of road accidents produced at national level in 2020 and 2021, and Figure 5 shows the fatality index for the same period.

Based on these data, the statistics show that Romania's road safety performance has not improved in the last year. The fatality rate increased from 26.2% in 2020 to 36.2% in 2021, determining the number of fatalities in total serious road events [7, p. 10]. Then, if we analyze the situation of road events that took place in 2022, according to the data presented by the General Inspectorate of the Romanian Police (IGPR) on January 13, 2024 in the Road Safety Bulletin, it results that on national roads there were 4,715 road accidents with serious consequences, resulting in 1,633 deaths, serious injuries to 3,695 people and slightly injuring 2,076 other people, all road users. Therefore, if we compare 2022 with 2021, there is a decrease of 200 serious accidents (-4.06), while the number of injuries (fatalities and serious injuries) in such events was reduced by 241 victims, a decrease of -4.32%. Looking at the environment where the events occurred, in 2022, the highest number of serious road accidents occurred on public roads in rural areas, 1,831 events, representing 39% of the annual total [5].

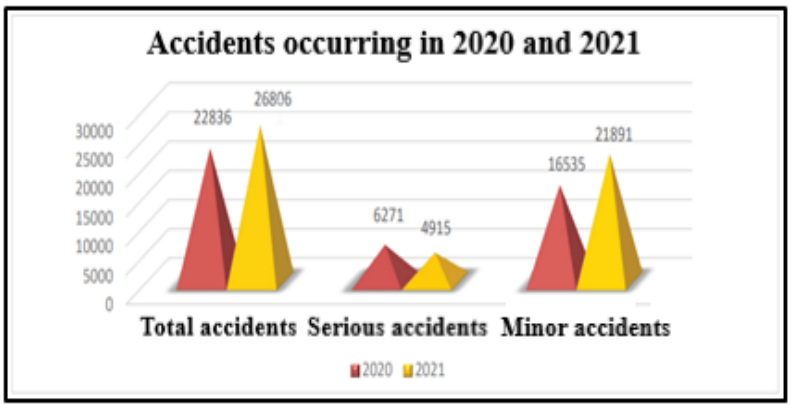

Figure 4. The situation of road accidents occurring at national level in 2020 and 2021 [7, p. 36].

About one third (32.1%) of the serious road accidents in 2022 are events in which pedestrians were seriously injured (1,514 accidents). Compared to the previous year, there is a slight decrease, with 80 fewer such events (-15%) in 2022.

Failure to adapt the speed of motor vehicles to the existing road conditions and irregular crossing by pedestrians remained the two most frequent causes of serious road accidents in 2022, followed by the causes listed in order of their frequency of occurrence, which are cyclists' misbehaviour, failure to give priority to pedestrians at marked crossings and failure to give priority to vehicles at intersections.

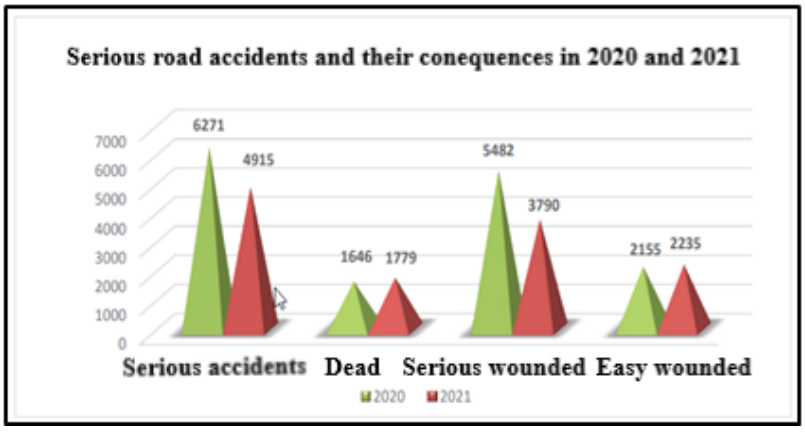

Figure 5. Motality index recorded at national level in the years 2020 and 2021 [7, p. 36].

With a share of 57.1% of serious accidents in 2022, the fault lies partly or entirely with vehicle drivers, who did not adapt their speed to the conditions and conditions imposed by the road infrastructure. As in 2021, pedestrians accounted

for the highest number of fatalities in 2022, accounting for 32.5% of all fatalities. According to data provided by the Romanian police authorities, pedestrians accounted for 50% of deaths in road accidents on the streets, 27.6% in those on national roads and 30.9% in events on county roads.
Regarding the situation of road events in 2023, in Romania, 4,524 serious accidents occurred on public roads, resulting in 1,545 people and serious injuries to 3,535 others. Compared to 2023 and 2022, there were 190 fewer accidents nationwide, resulting in 88 fewer fatalities and 160 fewer people seriously injured. In this respect, in order to increase the level of road safety on public roads in Romania, the specialised staff of the relevant department of the Ministry of Interior carried out 58,385 actions, 4,624 more than in 2022 (+8.6%) [10].

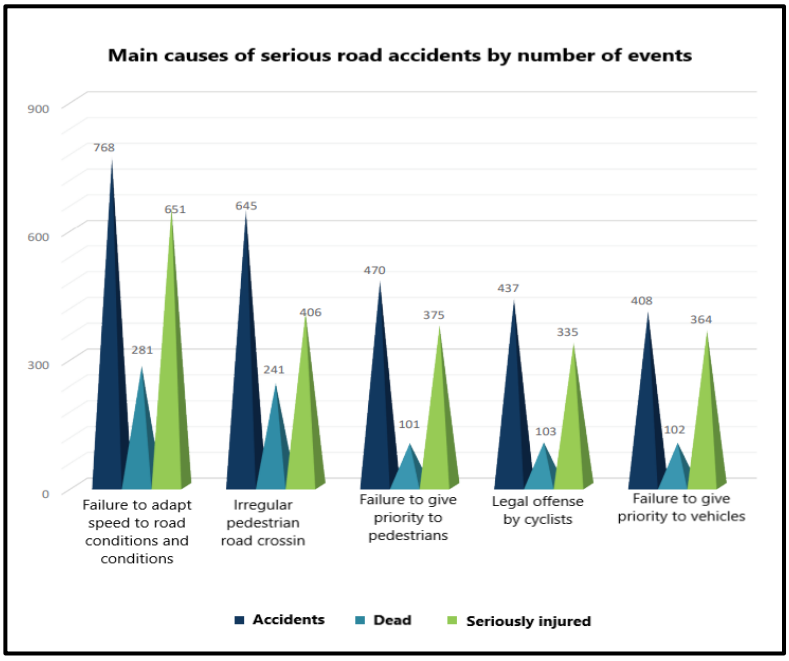

Figure 6. Main causes of serious road accidents in relation to the number of events in 2021 in Romania [7, p. 54].

Returning to the situation of road events occurred and recorded in 2021, we can say that in rural areas the fatality rate has a share of 37.2% compared to urban areas, where it has a share of 22.3% [11]. Figure 6 shows the main causes of serious road accidents according to the number of events in 2021 in Romania. The most vulnerable categories of traffic participants in 2021 were pedestrians, cyclists, motorcyclists and elderly people in rural areas. The number of road deaths increased slightly compared to the previous year due to an increase in the number of rural and extra-urban road deaths. However, in urban areas there was a decrease of 24.6% compared to 2021 in the number of serious road events (-581 serious road events), but also in the human consequences of serious road events (-49 deaths and -638 serious injuries). In villages serious road events on the roads through which they pass decreased by 22.05% (-542), while there were +35 deaths and -678 serious injuries. In the extra-urban environment in 2021 there were -16.1% serious road events compared to the previous year (-235), +99 deaths and -378 seriously injured persons [7, p. 11].

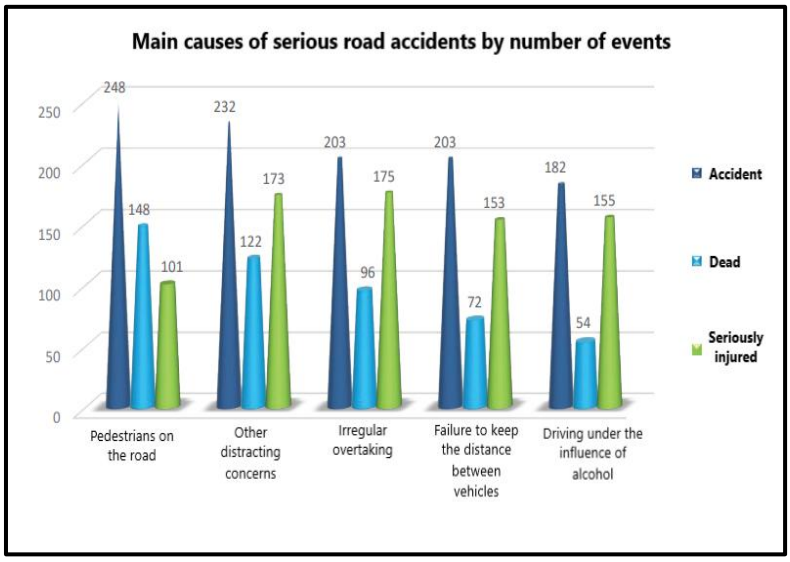

Figure 7. Main causes of serious road accidents by number of events in 2021 in Romania [7, p. 55].

The analysis of the data presented in Figure 6 shows that the main causes of serious road traffic events in relation to the number of events in 2021 at national level are: failure to adapt traffic speed to traffic conditions; indiscipline of pedestrians; failure to give priority at pedestrian crossings; traffic violations by cyclists; failure to give priority at intersections.

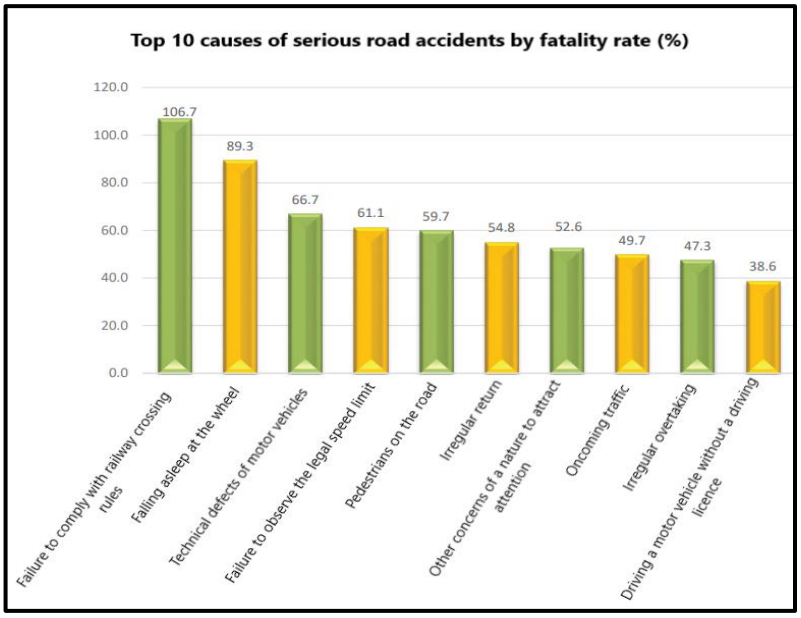

Figure 8. Top 10 causes of serious road accidents by fatality rate in 2021 in Romania (%) [7, p. 56].

Failure to adapt the speed of road vehicles to road conditions resulted in 768 serious road accidents in 2021, resulting in 281 fatalities and 651 serious injuries, 22.3% less than in 2020 (220 events) [7, p. 53].

Pedestrian indiscipline in road traffic generated 645 serious accidents in 2021, resulting in 241 fatalities and 406 serious injuries, down from 2020 (-113 events, -14.9%) [7, p. 53].

Failure to give priority to pedestrians by drivers of road vehicles resulted in -137 road accidents in 2021 compared to 2020 (-22.6%) [7, p. 53].

Of course, other causes are also at the root of serious road events in Romania (Fig. 7). In this regard, it can be seen that among the most significant causes of serious road events in 2021 were:

- failure to keep the distance between vehicles - resulted in fewer serious road accidents than in 2020 (down by 43 events, 17.5%);
- other activities likely to cause a loss of caution - caused more accidents than in 2020 (+9 events, 4%).

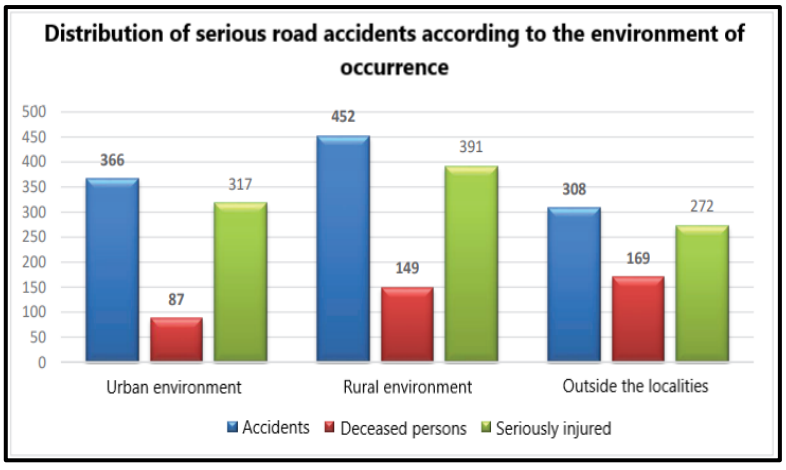

Figure 9. Distribution of serious road traffic events caused by young people according to the environment in 2021 in Romania [7, p. 70].

Investigations of the relationship between two or more road events, analysed from the perspective of the danger of causing casualties, complement the analysis of the causes of serious road accidents.

We present below the 10 main causes of serious road traffic events in 2021 in Romania (figure 8). These include such major road events as: people on the road, carelessness, overtaking, failing to keep the distance between vehicles and drink-driving.

From the analysis of the data presented in Figure 8, it can be seen that 49.3% of all road users died in road accidents in 2021.

Other reasons for the high number of serious road events in 2021 are [7, p. 57]:

- falling asleep at the wheel has resulted in 75 serious road accidents, killing 67 people and seriously injuring 63 others;
- speeding has resulted in 95 serious road traffic incidents, killing 58 people and seriously injuring 68 others;
- oncoming traffic caused 143 serious road accidents, killing 71 people and seriously injuring 125 others;
- disregard of road legislation on railway level crossings has resulted in a relatively small number of serious accidents, but the lethality of these road events is high, far exceeding the significance of any other situation taken as a benchmark. In 2021 this type of road event had a share of almost 107%.

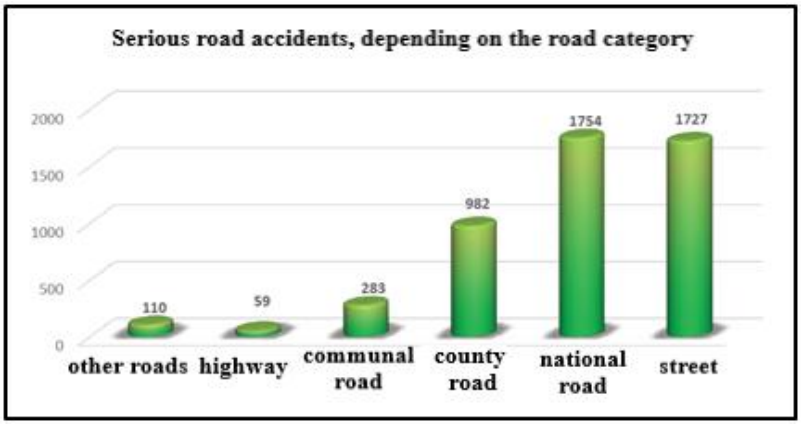

Figure 10. The serious road accidents that occurred in 2021 in Romania, depending on the road category [7, p. 37].

Another vulnerable group in road traffic are young people. Most accidents caused by young people (taken as the main culprit) were caused in villages. In this case, according to the data presented in Figure 9, there were 452 serious traffic accidents, but most of the serious road accidents resulting in fatalities among them occurred outside the villages (fatality rate 54.8%) [7, p. 69].

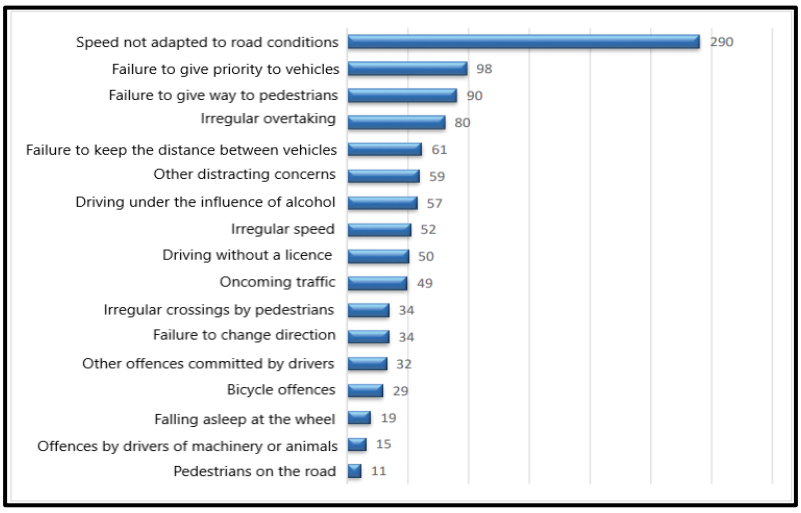

Figure 11. The main causes of serious road accidents caused by young drivers in 2021 [7, p. 71].

Depending on their category, roads continued to produce fatalities among road users in 2021. This is why it is important to highlight how shortcomings and inconsistencies in the road infrastructure, the lack of bypasses, the fact that the main roads cross localities, continue to cause casualties among drivers, pedestrians or travellers, lead to significant damage to material goods and goods or cause significant damage to the road transport system. In this respect, in urban areas the street is the first category of serious road accidents (35.1%), while in non-urban areas national roads are the second category of roads which have generated a large number of serious accidents, accounting for 35.7% of the total. Although major road events decreased on all types of roads compared to the previous year, the most significant reductions in the number of events were on national roads (-246 events, 12.3%) and urban streets (down by 611 road events, with a lower share of 26.1%) (Fig. 10) [7, p. 37].

Lack of adaptation of vehicle speed to road conditions is the main cause of 25.7% of all road accidents caused by young people aged 18-29 in 2021. Figure 10 shows the serious road accidents in 2021 in

Romania by road category. Serious road accidents on national roads are twice as high as those on urban streets. The situation is similar to that in 2020, when the national road was categorised as the road which, due to its condition, created the most fatalities among road users.

It follows that the road infrastructure in Romania, which is precarious, with major deficiencies, poorly maintained, not compliant with European requirements and standards, is the main source of serious road accidents in the road transport system in both urban and extraurban areas. The main causes of serious road accidents caused by young drivers in 2021 are shown in Figure 11.

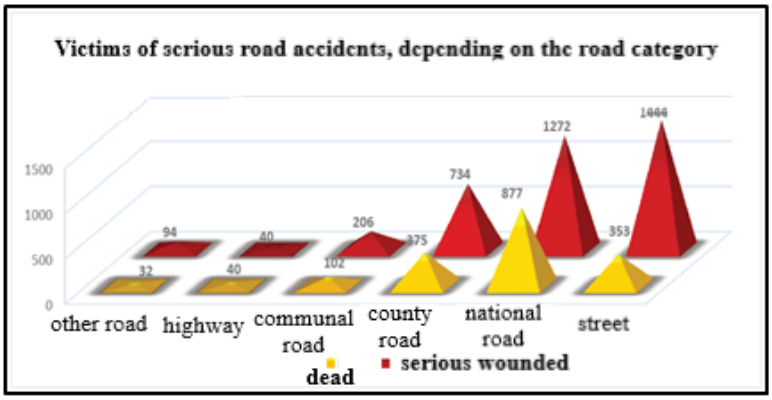

Figure 12. The number of victims resulting from serious road accidents in 2021 in Romania, depending on the road category [7, p. 38].

From the analysis of the data presented in Figure 11, it appears that the failure to adapt the speed of vehicles to road conditions and conditions is the root cause of serious road accidents caused by young people. Based on these data, we consider that young people driving road vehicles on Romanian roads are responsible for more than 1/3 of serious road accidents, which had as main cause the failure to adapt the speed of the vehicle to the road conditions.

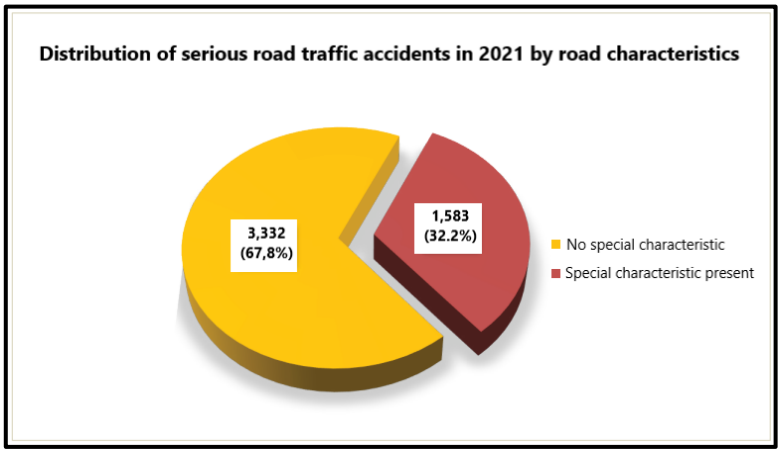

Figure 13. Distribution of serious road events in 2021 by road characteristics [7, p. 39].

Other causes that differentiate young drivers (18 - 29 years old) from other drivers in terms of serious road events are those causes that actually represent them, namely: not respecting the regulatory speed (54.7%), driving without a licence (43.8%) and irregular overtaking (39.4%) [7, p. 72]. Figure 12 shows the number of fatalities from serious road accidents in 2021 in Romania by road category.

Table 4 shows the fatality index values for each road category for the year 2021.

Table 4. Mortality index values for each road category in 2021 [7, p. 38].

Road category	Number of serious road accidents	Number of deceased persons	Mortality rate (%) $\frac{Number\ of\ deaths * 100}{Number\ of\ serious\ accidents}$
Other roads	110	32	29,1
Motorway	59	40	67,8
Communal road	283	102	52,9
County road	982	375	38,2

Road category	Number of serious road accidents	Number of deceased persons	Mortality rate (%) $\frac{Number\ of\ deaths * 100}{Number\ of\ serious\ accidents}$
National road	1.754	877	50
Street	1.727	353	20,4
TOTAL	**4.915**	**1.779**	**36,2**

It is found that, despite ranking second in the ranking of serious road events, accidents on urban streets have the lowest fatality rate. On motorways, the low frequency of road accidents is noticeable. The motorway is currently the safest road. At the same time, however, when road accidents do occur on the motorway, they have devastating effects due to the volume and intensity of traffic and the high speed of travel, as demonstrated by the highest fatality rate.

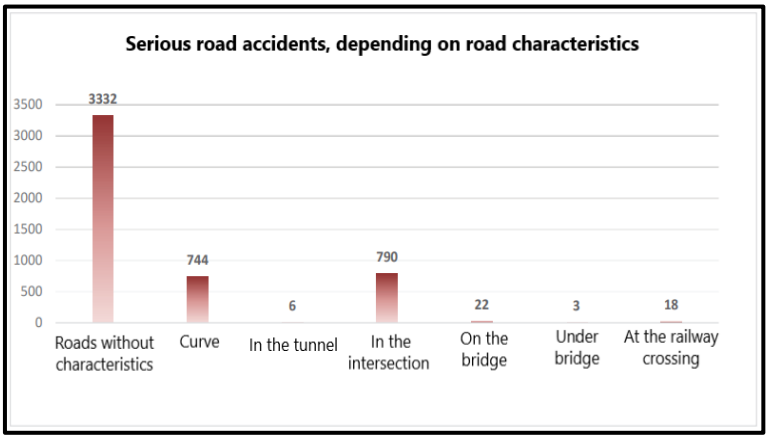

Figure 14. Serious road events caused in 2021 by specific road infrastructure characteristics [7, p. 40].

National roads, because of their characteristics and specificities, are invariably the scene of a high number of serious road accidents, with many casualties and often fatalities. Constructive elements such as bridges, tunnels, junctions, railway level crossings, curves, with their special characteristics, do not necessarily seem to influence the occurrence of serious road accidents.

Of all serious road events during 2021, almost 2/3 of them occurred on sections of roads without special features.

Figure 13 shows the distribution of serious road traffic accidents occurring in 2021 by road characteristics.

Featureless roads, junctions and bends presented the highest risk potential. In 2021 serious road traffic events on featureless roads amounted to 3,332 events. On curves there were 293 fewer events in 2021 than in 2020, with a share of 28.3%, and those generated at intersections were reduced by 271, with a share of 25.5%. This is also highlighted in the graph in Figure 14.

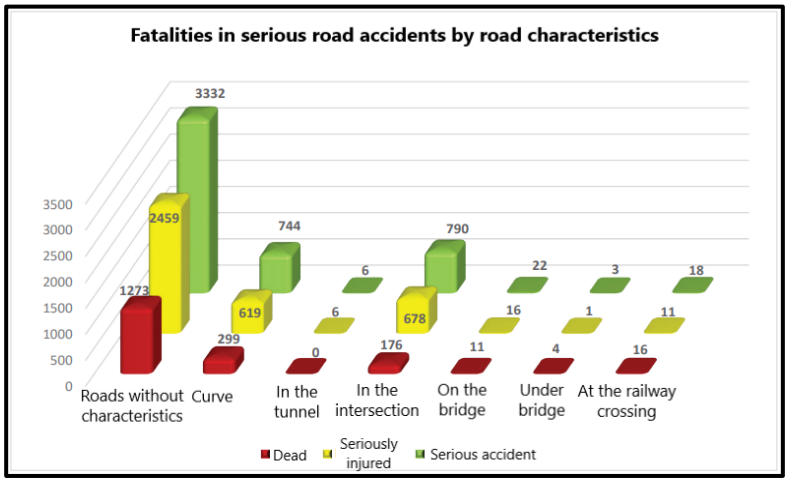

Figure 15. Number of fatalities resulting from road events in 2021 by road characteristics [7, p. 40].

Figure 15 shows the number of casualties resulting from road traffic incidents in 2021 by road characteristic.

Figure 16 shows the situation of persons killed in serious road accidents by category of road user and road category.

From the analysis of the data presented in Figure 16, it appears that the highest number of pedestrian fatalities occurs in road events on national roads (DN) or on streets (in urban areas). For the categories analysed, pedestrians accounted for 51.3% of fatalities in road accidents in urban areas, 28.6% of fatalities occurred in accidents on national roads and 30% of fatalities occurred in road accidents on county roads (DJ). The high number of fatalities on national and county roads is due to the indiscipline of drivers in road traffic, the low level of road safety education and the lack of preventive road behaviour. At the same time, road infrastructure elements such as: long distances between pedestrian crossings on national roads, lack of pavements in some areas and lack of street lighting (urban and extra-urban), have led to serious road accidents resulting in fatalities, serious injuries, slight injuries and significant material damage. In all these cases pedestrians were victimised. We specify that 8 people stopped or walking on the road and 16 drivers lost their lives in serious road accidents on the motorway. The toll of road accidents on the motorway is very low, as 40 people lost their lives on this road. Also, another category of road where pedestrians have been victimized are streets. Pedestrians are a major component of urban road traffic [7, p. 65].

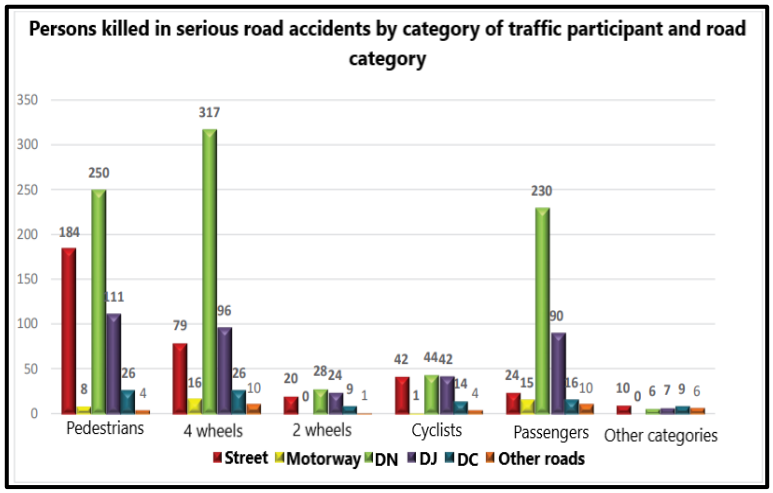

Figure 16. The situation of persons killed in serious road accidents by category of road user and road category [7, p. 65].

Table 5 shows the fatality values for serious motor vehicle events occurring in 2021 on road sections with different characteristics.

Table 5. Mortality values due to serious road events occurring in 2021 by road sectors with different characteristics. [7, p. 41].

Particularity of the road	Number of serious road events	Number of deceased persons	Mortality rate (%) $\frac{Number\ of\ deaths * 100}{Number\ of\ serious\ accidents}$
Without	3.332	1.273	38,2
Curve	744	299	40,2
Tunnel	6	0	0,0
Intersecțion	790	176	22,3
On the bridge	22	11	50
Under bridge	3	4	133,3
Railway level crossing	18	16	88,9
TOTAL	**4.915**	**1.779**	**36,2**

It is noted that a high mortality rate is caused by level crossings with railways. In 2021, 16 people lost their lives in 18 serious road accidents at railway level crossings (fatality rate 88.9%) [7, p. 41].

The poor infrastructure situation is also reported in the press in our country. Thus, according to data presented by a renowned daily newspaper, Romania ranks first in the European Union in two negative rankings in the field of road transport: the number of road deaths and the questionable quality of road infrastructure. But the authorities do not see a link between the two. According to data presented in the same newspaper, only 0.2% of road accidents are caused by the state of the infrastructure, but according to data obtained from National Road Infrastructure Management Company (CNAIR),

drivers have other opinions and believe that the state of the roads is much more responsible than the 0.2% reported by the authorities [12]. According to statistics in Romania, the most murderous national roads in the country are DN2, DN1 and DN6, followed by DN5 and DN7, in that order.
A relevant picture is shown in Figure 17. This shows the state of the DN2 national road, which does not provide safe operation for road traffic due to its poor design and construction.
The National Road 2 (DN 2) is the national road artery in Romania with a total length of 482 km. It connects the Romanian capital, Bucharest, to the north-eastern border with Ukraine via the Siret customs point (border). It crosses the counties of Ilfov, Ialomița, Buzău, Vrancea, Bacău, Neamț and Suceava. It is also known as the "Road of Death" because it is extremely dangerous. On this road 70-80 people lose their lives in road accidents every year. The Romanian authorities want to reconfigure it because, although the road is configured with one lane in each direction, it has a 2.5 m shoulder. For this reason, drivers mistake this shoulder for a second lane or the road as an expressway, step on the speed pedal hard, increase the speed of vehicles well above the legal limit and cause serious road accidents.

Figure 17. National Road 2 (DN2), which from a construction point of view does not offer road traffic safety due to undersizing [12]**.**

A large scale pilot project is targeting the DN1 and DN2 national roads as the main national roads that cause serious road accidents in our country. We aim to develop this system of economic and social partnership in the sense that, in addition to investments in road infrastructure that will increase safety on these national roads, especially in the area of black spots, we also want to develop this partnership on the education and training side (...) As for DN2, we have carried out a pilot project to increase road safety, the famous 2+1. The rules have been accepted and approved so that we can have a legal directive to develop this concept in Romania. The next step is to develop the DN2 national road, known as the "Road of Death", a road that causes many road accidents resulting in human casualties and significant material damage, to 2+1 over a greater distance. The most dangerous roads in Romania are still DN2 and DN1 (Bucharest – Borș Border). In third place is DN7 (Olt Valley). The three national roads mentioned above have recorded the most road accidents with fatalities [12].
In order to prevent possible road accidents, we believe that the first solution on national roads would be to widen to two lanes per direction where there is one and a half lanes (there is enough space) and to install guardrails in the middle. Then the bends should be well signposted and have a bumper in the middle as well. Intersections should be illuminated. Last but not least, all roads should have markings both on the road centreline and on the verge to mark the roadway, which is very important in foggy weather.

3. Road safety management carried out by authorities on road infrastructure in Romania
In order to reduce the number of events on public roads in Romania, the authorities of the Romanian Ministry of the Interior have imposed a series of actions. Thus, in 2021, a total of 53,258 specific actions were organised and carried out, as can be seen in Figure 18 [7, p. 90].

In the context of the present analysis, as far as vulnerable road users are concerned, traffic violations were completed in 2021 with the application of a total of 1,752,758 traffic fines, of which the most significant numerically are listed below [7, pp. 90-91]:

- disrespect for the legislation in force concerning pedestrian traffic - 73,006 contaventional sanctions;
- failure to give way to pedestrians - 17,925 contaventional sanctions;
- non-use of seat belts and restraint devices by road vehicle users - 216,127 contaventional sanctions;
- exceeding the legal limit – 651,296 contaventional sanctions;
- use of a mobile phone while driving without using a dedicated hands-free device - 35,387 contaventional sanctions;
- showing disrespect for traffic laws regarding overtaking vehicles in traffic – 27,218 contaventional sanctions;
- failure to observe the red color of the electric traffic light – 12,259 contaventional sanctions;
- driving of road vehicles by a driver under the influence of drugs or alcohol – 18,508 contaventional sanctions;
- showing disrespect for traffic laws regarding right of way – 12,454 contaventional sanctions;

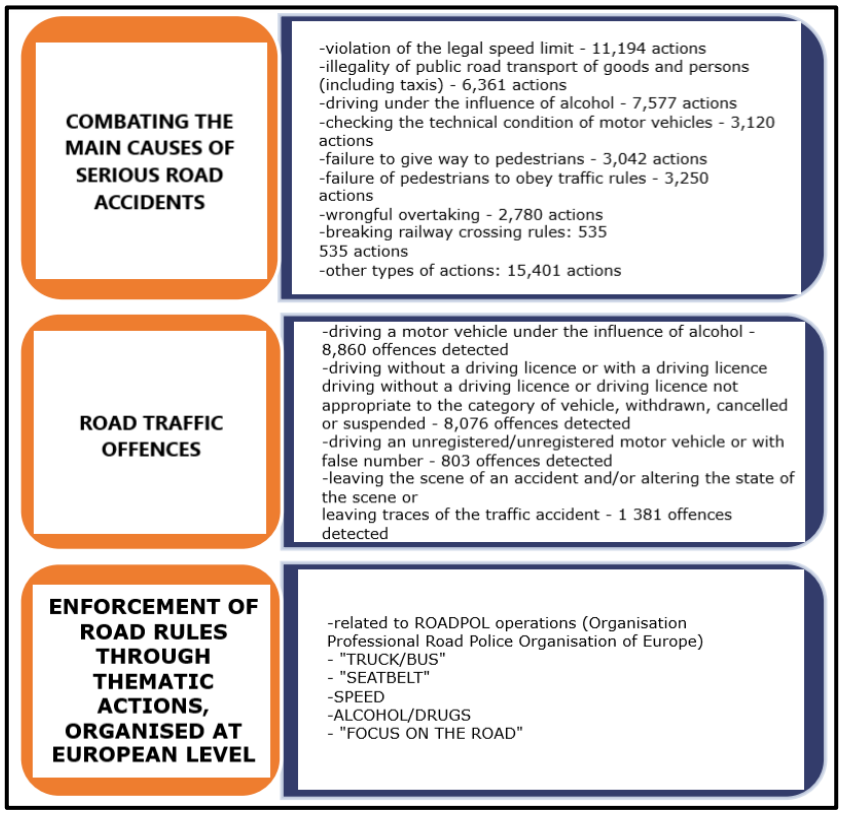

Figure 18. National road safety management actions in 2021 [7, p. 90].

In order to increase the level of road safety at national level in 2023, the road police structures of the Ministry of Administration and Interior carried out 58,385 actions, 4,624 more than in 2022 (an increase of 8.6%). [13].

At the same time, in order to increase road safety and to improve road traffic management, the Romanian police will install a radar type system for monitoring and measuring the speed of vehicles in traffic on a Black Hawk helicopter [14]. The aircraft was purchased at the end of 2023, along with 6 other helicopters that will serve the Emergency Medical Service for Resuscitation and Rescue (SMURD), 85% of the purchase amount being provided by European funds. The helicopter is put into service and is operable from spring 2024, reaches a maximum speed of 295 km/h, operates for 4 hours without interruption and lifts a maximum take off load of 10 tonnes. The radar equipment fitted is a high performance radar with a thermal imaging camera at night. Images captured and recorded by the system both day and night can be instantly transmitted to ground teams, so that interception of a driver who has not complied with road traffic laws can be made on the spot.

4. Sustainability of road infrastructure in Romania

The Romanian Government, through the National Recovery and Resilience Plan (NRRP), is committed to improving road safety legally, strategically and procedurally through the urgent

implementation of the *"Vision Zero"* programme established by the European Parliament. To this end, the National Road Safety Strategy for the period 2022-2030 has been created, in which further complementary measures will be taken, such as compliance with the standards set by EU policies, improvement of road infrastructure at the most critical points, control and safety in road traffic, development of databases to support police bodies in the management of specific activities.

In this context, the Romanian authorities have provided for a budget of EUR 4.5 billion for investment in road transport infrastructure and motorways in this plan [15]. This means taking to the road with an undersized road infrastructure, previously built and upgraded on an old infrastructure built in the 1950s and 1960s, which does not comply with operational and traffic safety standards, is polluting and poorly maintained, with oversized vehicle traffic areas, traffic jams and significant reductions in optimal travel speed.

The proposals and sustainability solutions of the Romanian authorities regarding road infrastructure in the NRRP are as follows [16]:

- increase the administrative capacities and corporate governance of the National Road Investment Company (NRIC) and the National Road Infrastructure Administration Company (NRIAC);
- investment in the development of major road infrastructure, particularly on motorway sections: A7; A8; A1 (Lugoj-Deva section); A3; link between A1 Timisoara Motorway and Timisoara Airport; link Slobozia - Drajna Noua on A2 Motorway; link Calarasi - Drajna Noua on A2 Motorway; link DN1 - Henri Coanda Airport - A3/A0 Motorway;
- investment and installation of intelligent traffic management systems, road signs and signals on roads;
- investment to develop a Traffic Management Centre (TMC);
- nvestment in information systems for road infrastructure users;
- investment in the interoperability of road transport systems;
- investment in electromobility (electric vehicle charging station infrastructure);
- investments to implement passive safety (barriers and impact attenuators; parapets and rolling railings; movable road lane dividers; night lighting, etc.);
- investment in overpasses and other technical solutions to eliminate black spots and digital marking systems;
- investment in pilot projects for mobility and autonomous vehicles.

5. Conclusions

This scientific paper has achieved its stated aim and objective by accurately describing up-to-date information and data for the period under review.

On December 31, 2023, 1,074 km of motorway were built and put into use in Romania. Our country is in last place in Europe in terms of the number of kilometres of motorway per 100,000 inhabitants.

On December 31, 2022, the length of public roads in Romania totalled 86,336 km, of which 20.4% = 17,582 km are national roads, 40.7% = 35,132 km are county roads and 3.9% = 33,622 km are municipal roads The density of roads per 100 km2 of territory has been steadily increasing, but not enough. The increase of this indicator was only 5.9% in 2020 compared to 1990, and in 2021 it decreased by 0.54%, reaching the same value in 2019. On December 31, 2021, the density of public roads was 36.2% per 100 km^2 of Romania's territory.

The latest EU-wide report on the state of road transport infrastructure (*European Transport and Infrastructure Board 2019*) shows that our country ranks poorly in this respect, coming last with a score of 2.96. According to estimates made by specialists, our country needs at this date a budget of 70 billion euros to bring the road infrastructure up to the standards required by the European Union.

Data made public by the European Commission show that although the number of road fatalities in the European Union has decreased, the situation in Romania is still impressive. Romania is the country with the highest number of victims, and the main cause is the disastrous state of the road network and the lack of motorway and expressway infrastructure. On roads full of potholes, "patched" here and there, with

dangerous areas with no protective parapets or guardrails, poorly equipped with signposts and signalling or information systems, traffic jams are constantly occurring, every busy period being marked by kilometre-long queues, and incidents are a daily occurrence. For car owners in Romania, car repair shop bills are a harsh and permanent reality. This justifies the breakdowns caused by our country's non-compliant road infrastructure. Most seriously, road incidents or accidents are events that result in the death, serious or minor injury of traffic participants. The harsh reality that we experience on a daily basis is also reflected in the European Commission's figures on fatal road accidents which have been presented by year in this paper. For this reason, according to the data provided by the Ministry of Transport, 1.52% of Gross Domestic Product (GDP) is lost every year in Romania due to road accidents.

Our country has for years been the European Union's leader in the number of road accidents and the number of people who die as a result. Statistics show that this will not change soon. The explanation lies between the poor road infrastructure and the lack of education of all road users. All this is also justified by the fact that in the event of a road accident, in addition to the possible loss of human life, there are other costs for the Romanian state. Here we are talking about hospitalisation costs, payments associated with the authorities intervening in road accidents (police, ambulance, fire brigade, etc.). At the same time, the costs of repairing damaged cars and road accident victims, which are insured and paid by insurance companies, must also be taken into account.

In Romania, during the period analysed (2020 - 2023), the majority of road events caused by young drivers occurred on the existing road infrastructure in villages. In this case, a total of 452 serious road accidents occurred in the country, but the highest number of serious road events resulting in fatalities occurred on roads outside villages (fatality rate 54.8%).

Failure to adapt the speed of road vehicles to road conditions is the cause of the most serious road accidents in 2021 (25.7% of all road accidents). They were generated by young drivers aged between 18 and 29 years. Romania remains the European champion in road accidents with a record number of more than 76 events every day.

Romania needs to invest massively and urgently in solutions to increase road safety. These include: modern, safe, efficient and sustainable infrastructure for every type of mobility; road safety education and electromobility programmes; legislative reforms to implement all European principles in the field of the road network.

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